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(54) Title: <b>SMALL CELL LUNG CARCINOMA SPECIFIC ANTIBODY AND ANTIGEN</b>			
(57) Abstract			
<p>The invention relates to a novel epitope of 180,000 daltons for the NCAM antigen and a monoclonal antibody, SEN7, directed against this antigen, and their use in diagnosis and therapy of small-cell carcinoma of the lung. The antibody SEN7 reacts significantly more selectively than previously known antibodies with cells of small-cell carcinoma of the lung, and binds with high avidity. In particular, no reaction occurs with leucocytes or healthy kidney or lung epithelial cells. The novel antigen is dominantly expressed by cells of small-cell carcinoma of the lung with a high copy number.</p>			

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**Small cell lung carcinoma specific antibody  
and antigen.**

**Description**

- 5      The invention relates to a novel tumour antigen and antibodies directed against this antigen, and to their use in diagnosis and therapy of small-cell carcinoma of the lung.
- 10     Small-cell carcinoma of the lung is prone to premature metastasis formation. Because of this, a surgical, radiological or chemotherapeutic treatment leads, in a large number of cases, only to a temporary cure. In regressions, therapy resistance against previously effective therapies, such as, for example, irradiation and chemotherapy, occur as a complication. Because of this, it has been considered in future to subject the patient after the conventional treatment of the primary tumour to a specific aftertreatment with antibodies or antibody-conjugated active substances. Labelled antibodies would also be useful for the demonstration of metastases by means of imaging processes or for the examination of tumour tissue by means of histological techniques.
- 15     A number of antigens which are expressed by cells of small-cell carcinoma of the lung are known; in accordance with the agreement which has been reached in specialist congresses (First and Second International Workshop on Lung Cancer Antigens; Brit.J. Cancer (1991) 63 (suppl.), pages 10-19; J.
- 20     Nat Cancer Inst. (1991) 83, 609-612), these are divided into seven groups. Antibodies against these antigens are also known. In animal models, these antibodies have occasionally been employed for the localisation of tumour cells. Important previously known antigens of small-cell carcinoma of the lung are the adhesion molecule of neuronal cells (neural cell adhesion molecule; NCAM), and antigens of the clusters 2 and w4. Further antigens are mucins, the Lewis<sup>y</sup> antigen, and the antigens of the ABO blood group system. Antibodies against NCAM and against cluster w4 antigens also bind to leucocytes. Antibodies against cluster 2
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The invention consequently relates to a murine monoclonal antibody having  
SEN7.2a.4 and the deposit number DSM ACC 2050, which secretes the  
monoclonal antibody SEN7.

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A novel antibody is provided which binds to the novel antigen specific-  
ally and with high avidity.  
The novel antigen is dominantly expressed with a high copy number  
by cells of small-cell carcinoma of the lung. According to the invention,  
cells. The novel antigen is dominantly expressed with a high copy number  
by cells of small-cell carcinoma of the lung. According to the invention,  
tumour does not occur on leucocytes or healthy kidney or lung epithelial  
specific than previously known antigens for tumour cells, and which in par-  
ticular has now been found and characterised which is significantly more  
aggressive than previous antigens and characterised by a high avidity.

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A novel antigen on the cell surface of cells of small-cell carcinoma of the  
lung has now been found and characterised which is significantly more  
aggressive than previous antigens and characterised by a high avidity.  
These antigens, in order to improve diagnosis and therapy of this cancer, in  
detail, the object is to provide improved antigens which are dominantly ex-  
pressed if possible exclusively in tumours in high copy number. Antibodies  
against antigens of this type should be distinguished by a high avidity.  
Also inadequate. The object of the invention is to provide novel tumour an-  
tigens of small-cell carcinoma of the lung, as well as antibodies against  
known tumour antigens and avidity of the specificity of previously

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immunological treatment of this disease, the specificity of previously  
rejection of cells of small-cell carcinoma of the lung. For methods for the  
antigens are not sufficiently selective. They do not permit the reliable de-  
tection of the lung and antibodies which are directed against these  
cell carcinoma of the lung a relative specificity for cells of small-

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tumour tissue.  
additionally useful so that the antibody is strongly concentrated in the  
immunological tumour therapy. A high avidity to the particular antigen is  
typical for systemic applications, as would be desirable for an  
antigen also bind to epithelial tissue. Because of this, antibody's for this

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The invention furthermore relates to humanised antibodies having murine hypervariable domains and human framework and constant domains, characterised in that they contain hypervariable domains from the monoclonal antibody SEN7.

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The invention also relates to an antigen, in particular of human origin, from cells of small-cell carcinoma of the lung, characterised in that it is bound by the antibody SEN7.

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The invention also relates to antibody conjugates, in particular conjugates with a toxin, a radioisotope and/or a labelling agent, characterised in that, as the antibody component, they contain the antibody SEN7 or a humanised antibody having the hypervariable domain of the antibody SEN7.

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The invention furthermore relates to the use of the antibody SEN7 or a humanised antibody having the hypervariable domain of the antibody SEN7 and/or of an antibody conjugate which, as the antibody component, contains the antibody SEN7 or a humanised antibody having the hypervariable domain of the antibody SEN7, for the production of a preparation for the treatment and/or diagnosis of small-cell carcinoma of the lung.

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The invention furthermore relates to the use of the antibody SEN7 or of a humanised antibody having the hypervariable domain of the antibody SEN7 and/or of an antibody conjugate which, as the antibody component, contains the antibody SEN7 or a humanised antibody having the hypervariable domain of the antibody SEN7, for the treatment and/or diagnosis of small-cell carcinoma of the lung.

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Customarily, monoclonal antibodies are obtained from rodent cells, in particular from cells of mice. These antibodies produce undesired immune reactions on in-vivo use in humans. In order to avoid these undesired immune reactions, antibodies which are intended for in-vivo use in humans are modified such that the human immune system no longer recognises these as foreign. The modification processes customary for these purposes include

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radioactively emitting isotopes such as, for example,  $^{131}\text{I}$  or  $^{125}\text{I}$  or by damage the diseased tissue. This damage can be effected, for example, by pounds are additinally or even exclusively employed which are intended to bodies is utilised directly. In other immunological therapy processes some immunological therapy processes, the biological action of the anti-

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ligands.

combinations used in indirectly labelling processes including the binding meaning both the labelling agents used in direct labelling processes and the responding to these examples the term labelling agent is to be understood as shown to the person skilled in the art according to the invention, correctly known to the person skilled in the art. According to the invention, correct selection of ligands of this type and the necessary binding processes are strongly binding ligands. The combinations biotin/avidin or biotin/-

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The selection of ligands of this type and the necessary binding processes are stepbystep, in particular, have proven suitable for this purpose.

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using agent directly to the antibody, but indirectly by means of additional

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the person skilled in the art in many cases it is useful not to link the label-

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substances or of enzymes and the necessary detection methods are known to

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peroxidase or alkaline phosphatase. The selection of suitable fluorescent

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example, fluorescein, or alternatively with enzymes, such as, for example,

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labelling is possible, for example, with fluorescent substances, such as, for

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person skilled in the art. These are often preferred in analytical tasks. La-

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belelling agents, further non-isotopic labelling agents are familiar to the

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labelling are known to the person skilled in the art. Besides these radio

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isotopes for isotope labelling and additional radioisotopes suitable for

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particular  $^{125}\text{I}$  and  $^{131}\text{I}$ , and also in  $^{111}\text{In}$  are customary for these purposes.

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radioisotopes; radioisotopes of yttrium, of rhodium and of technetium and in

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labelling agents (tracers). For example, antibodies can be labelled with

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in order to allow the analytical detection of antibodies, these are linked to

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as humanised antibodies.

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Modified antibodies of this type are designated according to the invention

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possible modification processes are known to the person skilled in the art.

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borough, C.A. et al. (1991) Protein Engineering 4, 773-783). Further

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CDR grafting (Jones, P.T. et al. (1986) Nature 321, 14-17; Kettie-

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5           cytotoxic substances, which include vegetable or bacterial toxins and cytostatics, such as, for example, ricin A, or gelonin. Further suitable radioactive isotopes and further suitable cytotoxic substances are known to the person skilled in the art. All these substances are combined according to the invention under the term toxins. The antibody transports the toxin to the intended site of action, for example the tumour, where it destroys the diseased cells.

10          Mice were immunised for the experiments which led to the provision of the antigen according to the invention and of the antibodies directed against this antigen. The immunogen used were cells of small-cell carcinoma of the lung which had previously been treated with neuraminidase. Cells of the human cell line SW2 were used in particular for this purpose. During the investigation of the resulting murine monoclonal antibodies, a cell line was  
15          discovered which secreted an antibody of the isotype IgG1, which was named SEN7. This antibody reacted with all small-cell carcinoma of the lung cell lines investigated (15). No reaction was observed with cell lines of pavement cell carcinoma of the lung (3) and of adenocarcinoma of the lung (3). It emerged that this antibody is specific for a previously unknown epitope of the neuronal cell adhesion molecule (NCAM), which belongs to none of the previously known groups. The cell line which secretes the antibody SEN7 is deposited in the German collection for microorganisms and cell cultures (Brunswick, DE) under the description SEN7.2a.4 (deposit number DSM ACC 2050).

25          The characterisation of the novel epitope of the NCAM molecule, which is recognised by the monoclonal antibody SEN7, is described in the following. The antibody SEN7 is also characterised. Further experimental details are found in the examples. The standard biochemical methods for antibody production and isolation, for characterisation of antibody and antigen and for derivatisation with radioactive isotopes are known to the person skilled in the art and are described in reference books and review articles, for example in Antibodies, a Laboratory Manual (Harlow and Lane (eds) (1988), Cold Spring Harbor Laboratory). Customary process variants are also described therein.  
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The fused cells were cultured and cloned and the clones were cultured again. The antibodies produced were examined by means of indirect immunofluorescence for the binding of unlabelled and neutravidase-treated SW220 cells. Cell lines were furthermore selected whose antibodies did not react with cells from marrow or with leukocytes. The binding of the antibody to the cells can be detected here with the aid of fluorescence labelling body to the cells can be detected here with the aid of fluorescence labelling which is recognised by the antibody SEN7. The cell line OHS which originates from small-cell carcinomas of the lung, and which reacts with the antibody SEN7, is used as the source of the antigen. Surface antigens of the body SEN7, is used as the source of the antigen. Surface antigens of the body SEN7 were purified from the culture filtrate by affinity chromatography on a protein A column.

Cells which produce SEN7 were cultured in a hollow fibre system. The antibody SEN7 isolated in this way was typed and emerged as belonging to the IgG1 isotype.

The antibody SEN7 isolated in this way was typed and emerged as belonging to the IgG1 isotype. Cells were in each case extracted by detergent treatment in the presence of a mixture of various protease inhibitors. The extracts were separated by electrophoresis on polyacrylamide gel in the presence of sodium dodecylsulphate according to a known method. The fractions separated in this way did not react with the antibody SEN7. Because of this, the separated fractions were first renatured with urea according to known methods. A consipicuous protein band having a molecular weight of 180,000 daltons was visible after this treatment. This band was present in the case of the cell lines SW2 and OHS under non-reducing conditions; it was absent in the negative control without first antibody.

For the immunisation of mice (BALB/c), cells of small-cell carcinoma of the lung (cell line SW2) were treated with neutravidase. Details of processes of this type and suitable immunisation schemes are known to the person skilled in the art from the literature, for example from Int. J. Cancer 35, 11-17 (1985) and Cancer Research 48, 412-417 (1988). The cell line P3X63Ag8.653 was used as a fusion partner. For the immunisation of mice (BALB/c), cells of small-cell carcinoma of the lung (cell line SW2) were treated and neutravidase-treated SW2 cells were cultured and cloned and the clones were cultured again. The antibodies produced were examined by means of indirect immunofluorescence for the binding of unlabelled and neutravidase-treated SW2 cells. Cell lines were furthermore selected whose antibodies did not react with cells from marrow or with leukocytes. The binding of the antibody to the cells can be detected here with the aid of fluorescence labelling which is recognised by the antibody SEN7. The cell line OHS which originates from small-cell carcinomas of the lung, and which reacts with the antibody SEN7, is used as the source of the antigen. Surface antigens of the body SEN7, is used as the source of the antigen. Surface antigens of the body SEN7 were purified from the culture filtrate by affinity chromatography on a protein A column.

- To characterise the antigen further, SW2 cells were cultured in the presence of tunicamycin. In this process, the biosynthesis of nitrogen-bound carbohydrates is inhibited. FACScan analysis of cultured cells of this type showed that they did not react with the antibody SEN7. The epitope to which the antibody SEN7 binds consequently contains an asparagine-bound oligosaccharide. The antigen is consequently a glycoprotein.
- 5
- To characterise the antibody, serial dilutions of SW2 cells were treated with isotopically labelled antibody. The free and the cell-bound content of the antibody was then determined by measurement of the radioactivity. The analysis of the data showed that the antibody binds with an affinity constant  $K_a = 2 \times 10^9 M^{-1}$ , and that about 200,000 binding sites per cell are present.
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- In order to determine the binding specificity of the antibody SEN7, investigations were carried out on viable cells of various carcinoma cell lines by means of indirect immunofluorescence. All 16 cell lines of small-cell carcinoma of the lung which were investigated reacted positively. No staining was observed in three investigated cell lines (U1752, HOTZ and LX1; squamous cell carcinoma, or undifferentiated carcinoma of the lung). The 15
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- same applies to three further investigated cell lines (A125, SLC52 and A549; adenocarcinomas).
- Investigations of leucocytes and peripheral blood lymphocytes demonstrated that the antibody does not bind to these cells. In further investigations it was also established by means of haemagglutination that no binding 25
- 30
- to erythrocytes takes place. In contrast to known antibodies to antigen groups cluster-1 and cluster-w4, which react non-selectively with leucocytes and lymphocytes, the antibody according to the invention does not react with these cells. The epitope of NCAM according to the invention is thus not present on the surface of these cells.

whatsoever.

merely illustrative, and not indicative of the disclosure in any way  
extrem. The preferred specific embodiments are, therefore, to constitute as  
using the preceding description, utilize the present invention to its fullest  
Without further elaboration, it is believed that one skilled in the art can,

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dose, relative to the fresh weight of the organ, was at most 32%.  
between fifteen and twenty five times smaller. The amount of the injected  
concentration in the liver (site of non-specific degradation reactions) was  
ion was specific; compared with the concentration in the tumor, the  
antibody SEN<sub>7</sub> was measured in the tumor than in the blood. This absorp-  
circulation; after the third day a three- to five-fold higher concentration of  
several days. The antibody was absorbed into the tumor from the blood  
organ distribution of the two antibodies was determined over a period of  
the antibody SEN<sub>7</sub>, the control antibodies to the class IgG<sub>1</sub>. The  
control, MG-I antibody (<sup>125</sup>I-labelled) was injected into the animals. Like  
time, a mixture of equal parts of SEN<sub>7</sub> antibody (<sup>125</sup>I-labelled) and, as a  
tumors had reached an approximate weight of 100 mg. At this point in  
subcutaneously into mice. The investigations were started as soon as the  
as a model system for imaging processes and for therapeutic use. For this  
purpose, 10<sub>7</sub> washed cells of the cell line SW2 were in each case injected  
The distribution of the antibody was determined in xenograft-bearing mice  
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completely negative.  
bronchi, lung, kidney, liver, large intestine, lymph nodes and pancreas was  
brain and pituitary gland tissue. The reaction with healthy tissues from skin,  
thyroid gland, adrenal gland, muscle, testicle, peripheral nerve, spinal cord,  
phoma) gave no reaction. Individual cell types reacted positively in healthy  
(adenocarcinoma, breast cancer, colon cancer, renal carcinoma and lymph-  
three samples respectively). All other tumor tissues investigated  
the lung, or carcinoid, reacted positively (six out of seven, or two out of  
by means of the known immunoperoxidase staining: small-cell carcinoma of  
Tissue samples of tumors and of healthy tissue were further investigated

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The entire disclosures of all applications, patents, and publications cited above and below, and of corresponding applications German DE 42 31 066, filed September 17, 1992, and DE 43 14 870, filed May 05, 1993, are hereby incorporated by reference.

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### Examples

The following abbreviations are used:

10	<u>PBS</u> :	phosphate-buffered saline solution (137 mM NaCl, 2.7 mM KCl, 8 mM Na <sub>2</sub> HPO <sub>4</sub> , 1.5 mM KH <sub>2</sub> PO <sub>4</sub> )
	<u>BSA</u> :	bovine serum albumin
	<u>TCA</u> :	trichloroacetic acid
	<u>DMSO</u> :	dimethyl sulphoxide
15	<u>DMF</u> :	dimethylformamide
	<u>TBS buffer</u> :	TRIS buffer (50 mM; pH 7.3) containing 1 M NaCl

For the culture of the hybridoma cell lines, if nothing else is described, a medium based on RPMI 1640 medium having the following additives is used: 10% (v/v) foetal calf serum, 10% (v/v) supplement H1 (BM-Condimed®, Boehringer Mannheim), 1% (v/v) L-glutamine, and 1% (v/v) of an insulin-oxalacetate-pyruvate solution (1.5 mg of cis-oxalacetic acid, 0.5 g of sodium pyruvate and 2000 units of insulin are added to 80 ml of H<sub>2</sub>O; then HCl is added until the solution is clear (pH 3-4) and the solution is made up to 100 ml with H<sub>2</sub>O).

Incubations, if not stated otherwise, are carried out at room temperature (R.T.; 15-28°C).

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The antibody isolated in this way is named SEN7. It belongs to the isotype IgG1/kappa, as investigations using test sticks (Amer sham, GB) show.

25 Fluorescence.

binds of the antibody to the cells can be detected by means of the stains fluorescein-labelled anti-mouse antibody (goat) and washed again. The cells are washed and treated with 50 µl of a solution which contains fluorescein isothiocyanate (FITC) for one hour with 10<sup>-7</sup> M of the antibody to be investigated in 25 µl of PBS with the addition of 0.1% sodium azide. The cells are washed and incubated in 25 µl of PBS with the addition of 0.1% sodium azide. The cells are washed and incubated at 4 °C for one hour with 10<sup>-7</sup> M of the anti-tumour, bone marrow or blood cells (2 × 10<sup>5</sup> cells) are in each case aliquoted into a test tube and incubated for 1 hour with 10<sup>-7</sup> M of the anti-marrow or anti-blood cells. For the immunofluorescence examination, 2 × 10<sup>5</sup> cells are selected whose antibodies do not react with cells from bone marrow or with leucocytes. Cell lines are selected which do not react with cells from bone marrow or with leucocytes. Cell lines are selected whose antibodies do not react with cells from bone marrow or with leucocytes. For the immunofluorescence examination, 2 × 10<sup>5</sup> cells are used cells are cultured and cloned and the clones are cultured again. The antibodies produced are examined by means of indirect immunofluo-

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rescence for the binding of untreated and neuraminidase-treated SW2 cells.

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The antibodies produced are examined by means of indirect immunofluo-

rescence for the binding of untreated and neuraminidase-treated SW2 cells.

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rescence for the binding of untreated and neuraminidase-treated SW2 cells.

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**Example 2: Production and purification of the antibody SEN7**

Cells of the cell line SEN7.2a.4 are cultured in a hollow fibre system (Acusyst, Technomara, CH) in RPMI 1640 medium with the addition of 5 10% by volume of foetal calf serum and 2 mM L-glutamine. The antibodies are adsorbed from the culture filtrate on a protein A column (BIO-RAD, Richmond/CA, USA). To do this, the culture filtrate is applied to the column in 50 mM Tris-HCl (pH 8.9) containing 3.3 M NaCl and the column is then washed with 50 mM Tris-HCl (pH 8.9) containing 3.3 M NaCl 10 until the eluate is protein-free. The bound IgG antibodies are eluted with 50 mM sodium acetate buffer (pH 6.0) containing 150 mM NaCl. The eluate is dialysed against 25 mM sodium acetate buffer (pH 5.5) and applied to 15 an ion exchange column (Mono-S®, Pharmacia, Uppsala, SE) and eluted using an NaCl gradient.

15 The antibody preparation obtained in this way proves to be homogeneous on investigation by means of SDS-PAGE and isoelectric focusing.

**Example 3: Isotopic labelling of the antibody SEN7**

20 For labelling with  $^{125}\text{I}$ , 40 µg of IodoGen® (Pierce, UK) are dissolved in 50 µl of chloroform. The solution is concentrated to dryness in a 1.5 ml vessel. A solution of 100 µg of SEN7 antibody in 50 µl of PBS, and a solution which contains 200 µCi of a  $^{125}\text{I}$  iodide salt are added to this vessel. The re- 25 action mixture is stirred for five minutes.

30 The reaction is then stopped by addition of 50 µl of a saturated solution of tyrosine (Fluka) in PBS. A column packed with SEPHADEX® G-25 is equilibrated with a solution of BSA (10 g/l) in PBS and used for the separation of the iodine which was not bound to protein.

The radiochemical purity of the labelled protein is determined by means of TCA precipitation and is greater than 95%.

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To do this, the suspensions are briefly mixed by means of a vortex mixer. Then the extract is then removed from the cell debris by centrifugation (1h, 10000xg). The extract are separated by electrophoresis on polyacrylamide gel (7.5 %) in the buffer system of O'Farrel in the presence of sodium dodecylsulfate. The gels are in each case remastered for 30 minutes in 6 M, 3 M and 1.5 M urea, then in water and in transfer buffer (pH 10.5; 10 mM 3-(cyclohexylamino)-1-propanesulfonic acid, 10% methanol). The proteins are then transferred by electrophoresis to an Immuno-Lite P membrane (Bio-Rad, CA) with 100 Vh. The membrane is preheated, as described by Johnson, D.A. et al. (1984) Gene Anal. Tech., 1, 328-334, with 50 g/l of skimmed milk powder in PBS and then incubated over night at 4 °C with a affinity-purified SEN7 having a concentration of 10-7M. Unbound antibody is washed out with a solution of goat anti-mouse IgG, which is conjugated with alkaline phosphatase. After washing, the bands are rendered visible by (CHAPS) and 0.1 % NaN<sub>3</sub>, and a mixture of various protease inhibitors (0.1 mM 1,10-phenanthroline, 0.1 mM 3,4-dichloroisocoumarin, 0.05 mM N-[N-(L-3-trans-captoprolyl)-L-leucyl]Arginine (E-64), 50 μg/g/ml of pepstatin A and 0.1 mg/ml of Chardin inhibitor peptide).

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**Example 4:** Western blot analysis of the SEN7 antigen

The iodine isotope  $I_{131}$  is introduced in an analogous manner. The same reaction is also used in order to prepare isotopically labelled derivatives of other substances (e.g. MG-1).

PCT/EP93/02042

A single protein band having a molecular weight of 180,000 is observed. In the case of the cell line OH3 this band is present under non-reducing conditions; it is missing in the negative control without the first antibody.

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**Example 5:** Determination of the binding constants of SEN7

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A serial dilution of SW2 cells in 100 µl of PBS with the addition of 1 % bovine serum albumin and 0.1 % sodium azide, starting with  $10^7$  cells, is prepared. Each dilution is treated for two hours at 4 °C with 40 ng of isotopically labelled antibody according to Example 3. The cells are then centrifuged off and the free and the cell-bound amount of the antibody are determined by measurement of the radioactivity.

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The analysis of the data establishes that the antibody binds with an affinity constant  $K_a = 2 \times 10^9 \text{ M}^{-1}$ , and that about 200,000 binding sites per cell are present.

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**Example 6:** Reaction of antibody SEN7 with NCAM-transfected cells

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The reaction of the antibody SEN7 was investigated in cells which had been transfected with a complementary DNA. This cDNA codes for a 140,000 daltons isoform of a human NCAM (neuronal cell adhesion molecule) from the small-cell bronchial carcinoma cell line SW2. These stable transfectants were prepared as follows.

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The coding region for the 140,000 daltons isoform of NCAM was cloned from cDNA by means of the PCR method (polymerase chain reaction). The polyA+RNA, from which the cDNA was synthesised, originated from the human small-cell bronchial carcinoma cell line SW2. Three overlapping DNA fragments were prepared and each was then cloned and sequenced in pSK+Bluescript (Stratagene GMBH, Zurich). Fragment 1 was cut by means of restriction enzymes (EcoRI/NotI) and the cut piece was isolated. Fragment 2 was cut using EcoRI/BstBI and isolated; fragment 3 was cut using BstBI/NotI and isolated. These three cut fragments were joined again and gave the coding sequence of the human 140,000 daltons NCAM. This clone

The cells were then incubated with  $^{125}\text{I}$ -labelled antibody SEN7 (using half saturation concentration). Unbound antibody was washed out and the still bound radioactivity was determined. As can be seen from the following table 1, no or only slight competition of the other antibodies with SEN7 for binding to tumor cells was found.

treated with an excess of competing first NCAM antibodies. treated carcinoma cells. In a radiolimmunoassay, 10<sup>3</sup> cells were first challenged for their action blocking SEN7 binding to bronchial carcinomas (Moolenaar, C.E.C.K., et al., Cancer, 63: Suppl. XIX, 24-28, 1991), were investigated for their action blocking SEN7 binding to bronchial carcinomas (Moolenaar, C.E.C.K., et al., Cancer Res., 50: 1102-1106, 1990; Hida, T., et al., Br. J. Cancer, 63: Suppl. XIX, 24-28, 1991), were investigated for their action blocking SEN7 binding to bronchial carcinomas (Moolenaar, C.E.C.K., et al., Cancer Res., 50:

NCAM antibodies, which recognise three different epitopes on small-cell bronchial carcinomas (Moolenaar, C.E.C.K., et al., Cancer Res., 50:

#### Example 7: Competition of antibody SEN7 and other NCAM antibodies

This clone was positive with the antibody SEN7 and other known anti-NCAM antibodies. This clone was negative with an anti-cluster-w4/CD24 antibody SWA11.

expression of NCAM was selected. A clone having particularly high and uniform expression of NCAM. The resistant clones were investigated for surface netcillin resistance gene. The vector used contains a gene which were then selected for genetic resistance; the vector used contains a gene, 40 ng of linear plasmid were inserted in 10<sup>7</sup> mouse cells. The cells Nature 322: 840-842) was carried out by means of electroporation. To do this, 40 ng of linear plasmid were inserted in 10<sup>7</sup> mouse cells. The cells transfected into a mouse pre-B cell line B-300. 19 (Reich, et al., 1986,

(Invitrogen, Heidelberg) by means of HindIII/NotI restriction enzymes. was then subcloned in the eukaryotic expression vector PR/CMV

Table 1: Binding competition in small-cell bronchial carcinoma cells between the radiolabelled SEN7 antibody and non-labelled antibodies against NCAM<sup>a</sup>)

	Non-labelled antibodies	SAM (cpm) <sup>b</sup> )	% Binding
	none	(138)	100
	SEN7	(1588)	1
	<u>first epitope</u>		
10	123C3	(1469)	39
	123A8	(1967)	55
	NCC-Lu-234	(1994)	74
	NKI-nbl-3	(2352)	87
15	SEN36	(1656)	126
	<u>second epitope</u>		
	MOC-21	(2214)	68
	NCC-LU-246	(1644)	78
	NE25	(1447)	85
20	MOC-1	(1668)	103
	<u>third epitope</u>		
	NKH1	(2282)	33
	Leu 19	(1138)	99

25 a) Proportion of binding of SEN7 in %

b) Bound first (competing) antibody was quantified by means of <sup>125</sup>I-labelled sheep anti-mouse antibody.

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Tissue	Reaction	(Number of samples)	20
the lung (7)	positive (6 of 7)	Adenocarcinoma (3)	Carcinoma of the breast (4)
Colonic carcinoma (4)	negative	Renal carcinoma (4)	Lymphoma (1)
Skin (3)	negative	Bronchi (4)	Lung (3)
Kidney (4)	negative	Liver (3)	Lymph nodes (3)
Pancreas (3)	negative		

Table 2

Tissue samples of tumours and of healthy tissue are examined by means of immunoperoxidase staining. Frozen sections (thickness 5 µm) are prepared and mounted on a slide coated with gelatine. After a preincubation with 0.3% (v/v)  $H_2O_2$  in methanol and with pig serum (2%), the sections are covered with a solution of SEN7 and incubated at room temperature for one hour. The sections are then washed and first treated with peroxidase-conjugated anti-mouse rabbit serum, then with peroxidase-conjugated anti-rabbit pig serum. The peroxidase is rendered visible using 3,3'-diaminobenzidine as chromogenic substrate. The sections are counterstained with haematoxylin. The results are summarised in the following table 2:

	Thyroid gland (5)	positive (follicle cells)
	Adrenal glands (3)	positive (Zona glomerulosa and medulla)
5	Skeletal muscle (3)	positive (individual fibres)
	Testicles (1)	positive (Leydig's cells)
	Peripheral nerves (4)	positive (axons)
	Bone marrow (3)	positive
	Brain (3)	positive (neuropil)
	Pituitary gland (2)	positive (cells of the posterior lobe and individual cells of the anterior lobe)

**Example 9: Xenograft investigation in mice**

- 15      **Preparation:**  $10^7$  washed cells of the cell line SW2 are in each case injected subcutaneously into female ICR nu/nu mice (4-6 weeks old) which are fed under pathogen-free conditions. The investigations are started as soon as the tumours have reached an approximate weight of 100 mg (about two to three weeks after the injection).
- 20      **Procedure:** A mixture of equal parts of SEN7 antibody (6 µg/animal;  $^{125}\text{I}$ -labelled using 12 µCi) and, as the control, MG-1 antibody (6 µg/animal;  $^{131}\text{I}$ -labelled using 12 µCi) is injected i.v. into the animals. Like the antibody SEN7, the control antibody belongs to the class IgG1.
- 25      Four mice in each case are sacrificed after 2, 4 and 7 days and the various organs are washed with PBS and weighed. The two antibodies are measured using a two channel gamma counter (15-80 keV and 260-470 keV). The results are summarised in the following table 3:

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a) Mean value  $\pm$  standard deviation ( $n = 3$  or 4)

Organ:	Quotient tumour/blood	Quotient tumour/liver	% injected dose/g of organ a)	Organ:	Quotient tumour/blood	Quotient tumour/liver	% injected dose/g of organ a)
Tumour	19.3 $\pm$ 5.0	33.4 $\pm$ 10.3	10.1 $\pm$ 4.3	Blood	10.2 $\pm$ 1.5	10.3 $\pm$ 2.8	1.8 $\pm$ 0.7
Liver	2.4 $\pm$ 0.3	2.1 $\pm$ 0.9	0.4 $\pm$ 0.1	Heart	1.0 $\pm$ 0.2	0.9 $\pm$ 0.4	0.2 $\pm$ 0.1
Lung	2.2 $\pm$ 0.4	1.4 $\pm$ 0.4	0.5 $\pm$ 0.3	Kidney	1.4 $\pm$ 0.4	1.2 $\pm$ 0.6	0.2 $\pm$ 0.0
Spleen	1.6 $\pm$ 0.3	1.4 $\pm$ 0.5	0.3 $\pm$ 0.1	Muscle	0.6 $\pm$ 0.1	0.6 $\pm$ 0.1	0.1 $\pm$ 0.0
Brain	0.1 $\pm$ 0.0	0.1 $\pm$ 0.0	0.0 $\pm$ 0.0	Bone	0.8 $\pm$ 0.2	0.5 $\pm$ 0.1	0.1 $\pm$ 0.0

Table 3:

## INDICATIONS RELATING TO A DEPOSITED MICROORGANISM

(PCT Rule 13bis)

<b>A.</b> The indications made below relate to the microorganism referred to in the description on page <u>5</u> , line <u>21-24</u>	
<b>B. IDENTIFICATION OF DEPOSIT</b>	
Name of depositary institution <b>DSM-Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH</b>	
Address of depositary institution ( <i>including postal code and country</i> ) <b>Mascheroder Weg 1b 38124 Braunschweig</b>	
<b>Date of deposit</b> <b>16.09.92</b>	<b>Accession Number</b> <b>DSM ACC2050</b>
<b>C. ADDITIONAL INDICATIONS</b> ( <i>leave blank if not applicable</i> )      This information is continued on an additional sheet <input type="checkbox"/>	
<b>D. DESIGNATED STATES FOR WHICH INDICATIONS ARE MADE</b> ( <i>if the indications are not for all designated States</i> ) ---	
<b>E. SEPARATE FURNISHING OF INDICATIONS</b> ( <i>leave blank if not applicable</i> ) The indications listed below will be submitted to the International Bureau later ( <i>specify the general nature of the indications e.g., "Accession Number of Deposit"</i> ) ---	
For receiving Office use only	
<input checked="" type="checkbox"/> This sheet was received with the international application <i>R.P.</i> Authorized officer <b>F.L.R. PETHER</b>	
For International Bureau use only	
<input type="checkbox"/> This sheet was received by the International Bureau on: Authorized officer	

1. Murine monoclonal antibody having the designation SEN7.
2. Hybridoma cell line having the designation SEN7.2A.4 and the deposit number DSM ACC 2050, which secretes the monoclonal antibody according to Claim 1.
3. Antibody from cells of small-cell carcinoma of the lung, characterised in that it is bound by an antibody according to Claim 1.
4. Antibody according to Claim 3, characterised in that it is a membrane-bound glycoprotein having a molecular weight of 180,000.
5. Humanised antibody having murine hypervariable domains and human framework and constant domains, characterised in that it contains hypervariable domains from the monoclonal antibody according to Claim 1.
6. Antibody conjugate, characterised in that it contains an antibody according to one of Claims 1 or 5 as the antibody component.
7. Use of an antibody according to one of Claims 1 or 5, or of an antibody conjugate according to Claim 6 for the production of a preparation for the treatment and/or diagnosis of small-cell carcinoma of the lung.
8. Use of an antibody according to one of Claims 1 or 5, or of an antibody conjugate according to Claim 6 for the treatment and/or diagnosis of small-cell carcinoma of the lung.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 93/02042

## A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C12P 21/08, C07K 15/00, A61K 39/395, G01N 33/574  
 According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: C12P, C07K, A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## CANCERLIT, MEDLINE, WPIL

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Cancer Research, Volume 48, August 1988, Robert Waibel et al, "Tumor-associated Membrane Sialoglycoprotein on Human Small Cell Lung Carcinoma Identified by the IgG2a Monoclonal Antibody SWA20", page 4318 - page 4323, see esp. pages 4322-23  --	3,4
X	EP, A2, 0443599 (BEHRINGERWERKE AKTIENGESELLSCHAFT), 28 August 1991 (28.08.91)  --	3,4
X	EP, A2, 0323802 (SANDOZ AG ET AL), 12 July 1989 (12.07.89), see esp. pages 6-7  --	3,4

 Further documents are listed in the continuation of Box C. See patent family annex.

- \* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "B" other document but published on or after the international filing date
- "L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "Z" document member of the same patent family

Date of the actual completion of the international search

26 October 1993

Date of mailing of the international search report

23 -11- 1993

Name and mailing address of the International Searching Authority

European Patent Office, P.B. 5818 Patentzaan 2  
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Authorized officer

CARL OLAF GUSTAFSSON

Category	Claim(s) of document, with indication, where appropriate, of the relevant passages Relevant to claim No.	PCT/EP 93/02042	(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT
A	EP, A2, 0356397 (SANDOZ-PATENT-GMBH ET AL), 28 February 1990 (28.02.90)	3,4	Journal of Pathology, Volume 159, 1989, R.E. Kibbeler et al, "expression of the embryonal neuronal cell adhesion molecule-N-cam in lung carcinoma. Diagnostic usefulness of monoclonal antibody 735 for the distinction between small cell lung cancer and non-small cell lung cancer", page 23 - page 28, see fig. 4
X	CHST, Supplement, Volume 103, No 4, April 1993, Thomas J. Lynch Jr., "Immunotoxin Therapy of Small-Cell Lung Cancer". N901-Blocked Ricin for relapsed Small-Cell Lung, page 436S - page 438S, see esp. page 438S	3,4	Eur J Cancer, Volume 27, No 4, 1991, "Neural Cell Adhesion Molecule Expression, Prognosis in lung Carcinoma", page 431 - page 435, see "Discussion"
X	Cancer Research, Volume 50, February 1990, C.E. Kirby Moilenar et al, "Expression of Neural Cell Adhesion Molecule-related Sialoglycoprotein in Small Cell Lung Cancer and Neurorhabdiosome Cell see esp. page 1105 Lines H69 and CHP-224, page 1102 - page 1106,	3,4	Cancer Research, Volume 53, June 1993, Robert Mabtej et al, "Monoclonal Antibody SEN/ Recognizes a New Epitope on the Neural Cell Adhesion Molecule Present on Small Cell Lung Cancer but Not on Lymphocytes" page 1-8
P,X	see esp. page 1105 Lines H69 and CHP-224, page 1102 - page 1106, in Small Cell Lung Cancer and Neurorhabdiosome Cell see esp. page 1105 see esp. page 1105	1-8	see esp. page 1105 Lines H69 and CHP-224, page 1102 - page 1106, in Small Cell Lung Cancer and Neurorhabdiosome Cell see esp. page 1105 see esp. page 1105

S. 7029

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

01/10/93

International application No.

PCT/EP 93/02042

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A2- 0443599	28/08/91	AU-A-	7125491	29/08/91
		DE-A-	4005630	05/09/91
		JP-A-	5030990	09/02/93
EP-A2- 0323802	12/07/89	JP-A-	2154694	14/06/90
EP-A2- 0356397	28/02/90	JP-A-	2219594	03/09/90

